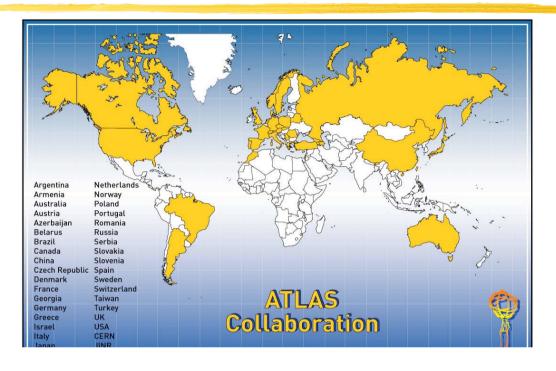


The ATLAS Collaboration





35 nations
158 istitutions
~1650 scientists

Albany, Alberta, NIKHEF Amsterdam, Ankara, LAPP Annecy, Argonne NL, Arizona, UT Arlington, Athens, NTU Athens, Baku, IFAE Barcelona, Belgrade, Bergen, Berkeley LBL and UC, Bern, Birmingham, Bologna, Bonn, Boston, Brandeis, Bratislava/SAS Kosice, Brookhaven NL, Buenos Aires, Bucharest, Cambridge, Carleton, Casablanca/Rabat, CERN, Chinese Cluster, Chicago, Clermont-Ferrand, Columbia, NBI Copenhagen, Cosenza, INP Cracow, FPNT Cracow, Dortmund, TU Dresden, JINR Dubna, Duke, Frascati, Freiburg, Geneva, Genoa, Giessen, Glasgow, LPSC Grenoble, Technion Haifa, Hampton, Harvard, Heidelberg, Hiroshima, Hiroshima IT, Indiana, Innsbruck, Iowa SU, Irvine UC, Istanbul Bogazici, KEK, Kobe, Kyoto, Kyoto UE, Lancaster, UN La Plata, Lecce, Lisbon LIP, Liverpool, Ljubljana, QMW London, RHBNC London, UC London, Lund, UA Madrid, Mainz, Manchester, Mannheim, CPPM Marseille, Massachusetts, MIT, Melbourne, Michigan, Michigan SU, Milano, Minsk NAS, Minsk NCPHEP, Montreal, McGill Montreal, FIAN Moscow, ITEP Moscow, MEPhI Moscow, MSU Moscow, Munich LMU, MPI Munich, Nagasaki IAS, Naples, Naruto UE, New Mexico, Nijmegen, BINP Novosibirsk, Ohio SU, Okayama, Oklahoma, Oklahoma SU, Oregon, LAL Orsay, Osaka, Oslo, Oxford, Paris VI and VII, Pavia, Pennsylvania, Pisa, Pittsburgh, CAS Prague, CU Prague, TU Prague, IHEP Protvino, Ritsumeikan, UFRJ Rio de Janeiro, Rochester, Rome I, Rome III, Rome III, Rutherford Appleton Laboratory, DAPNIA Saclay, Santa Cruz UC, Sheffield, Shinshu, Siegen, Simon Fraser Burnaby, Southern Methodist Dallas, NPI Petersburg, Stockholm, KTH Stockholm, Stony Brook, Sydney, AS Taipei, Tbilisi, Tel Aviv, Thessaloniki, Tokyo ICEPP, Tokyo MU, Toronto, TRIUMF, Tsukuba, Tufts, Udine, Uppsala, Urbana UI, Valencia, UBC Vancouver, Victoria, Washington, Weizmann Rehovot, Wisconsin, Wuppertal, Yale, Yerevan

Point 1 : ATLAS experimental area

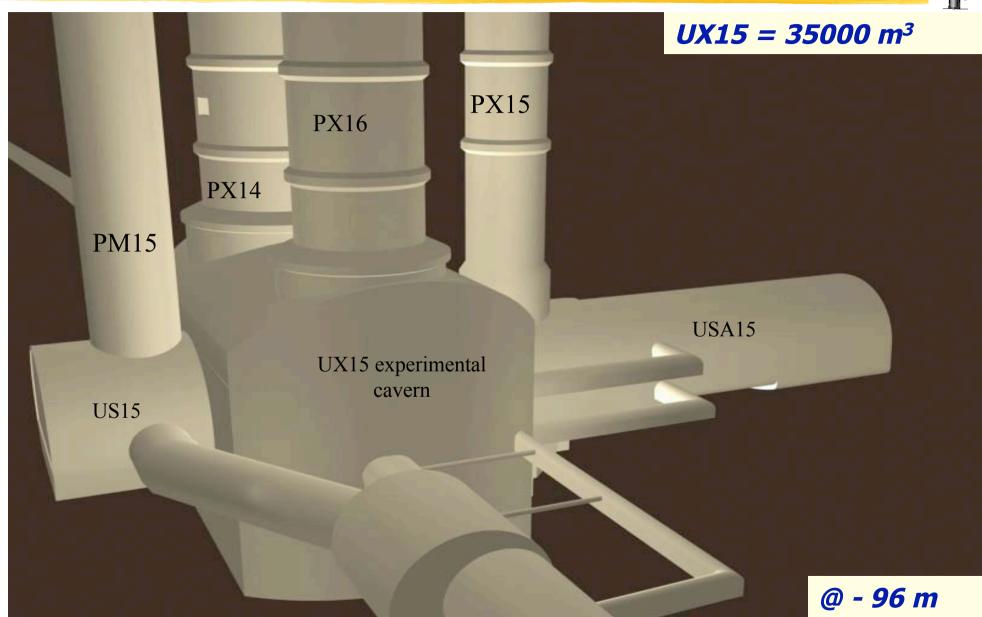


All buildings delivered, all surface buildings infrastructure operational

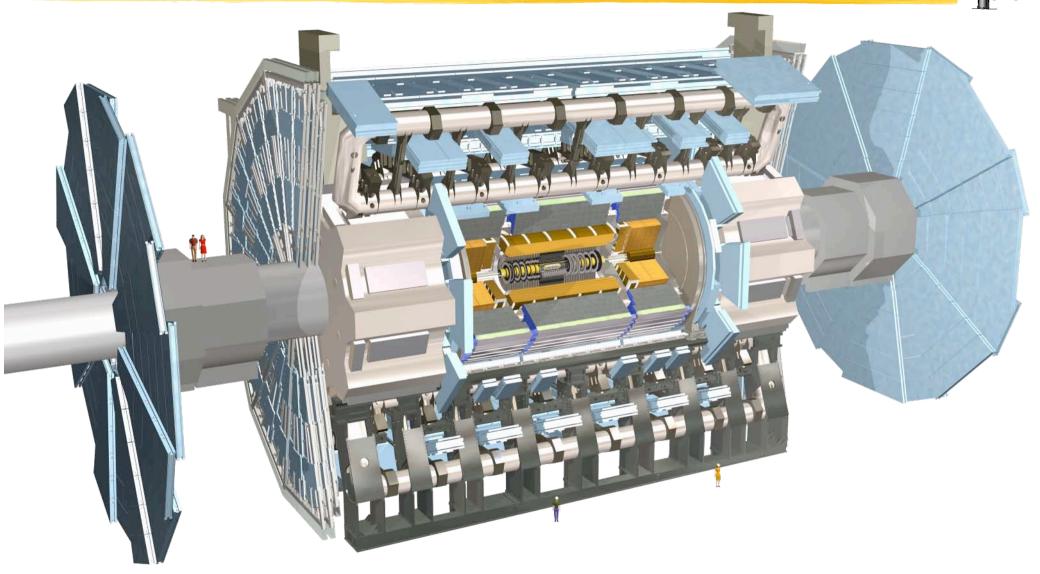


Point 1 : underground experimental area











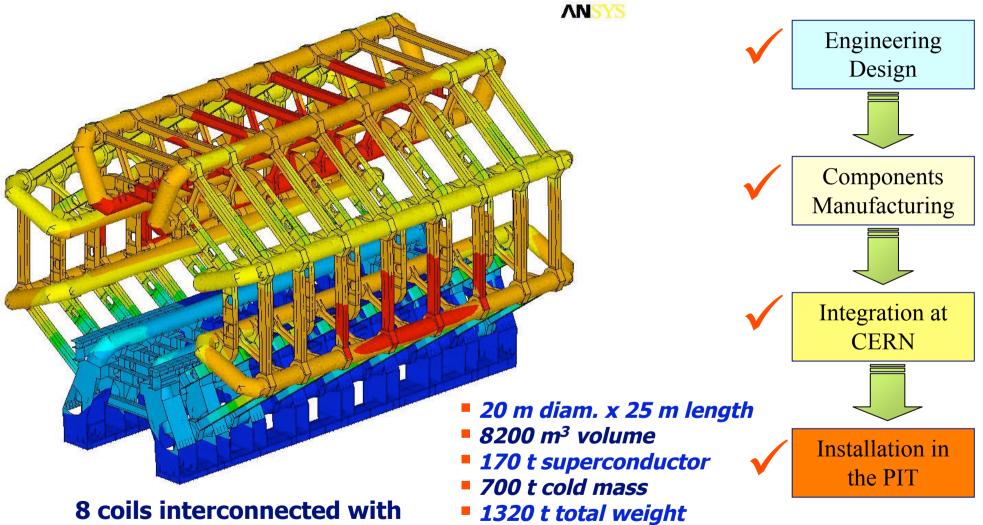
Magnets Project

Barrel Toroid + 2 End Cap Toroids + Central Solenoid + Cryogenics + Services

> Construction over 8 years, 1998-2006 Installation over 3 years, 2004-2007

The Barrel Toroid





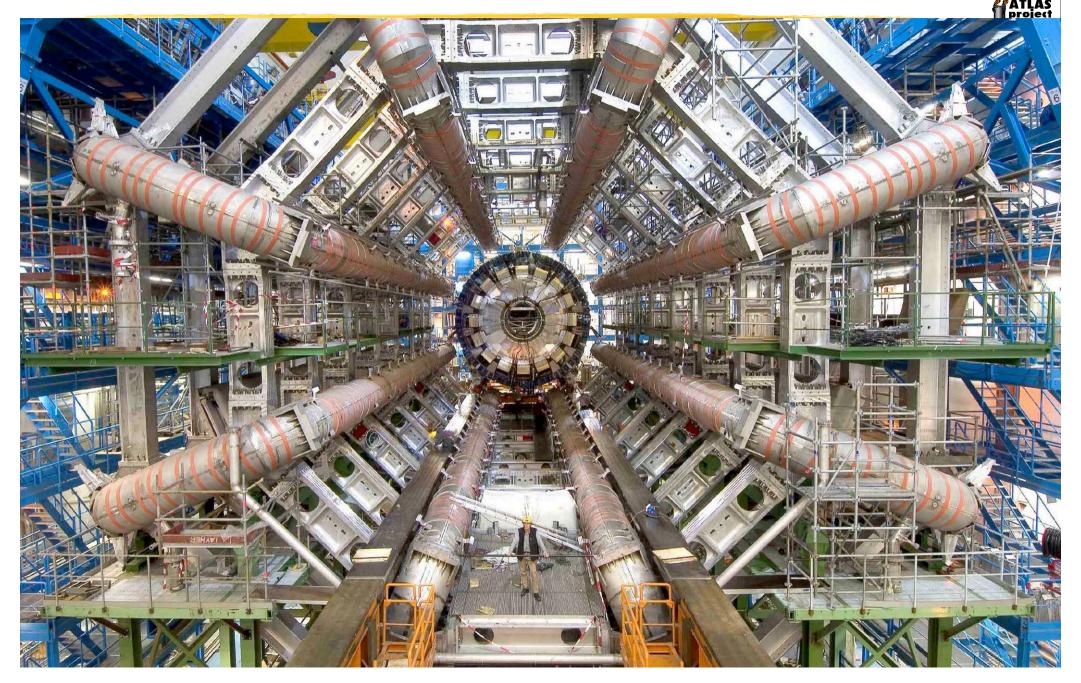
8 coils interconnected with an aluminum warm structure

20.5 kA at 4.1 T

1.55 GJ stored Energy

90 km superconductor

.... End of November 2005



All components manufactured















Cold mass insertion in its vacuum vessel





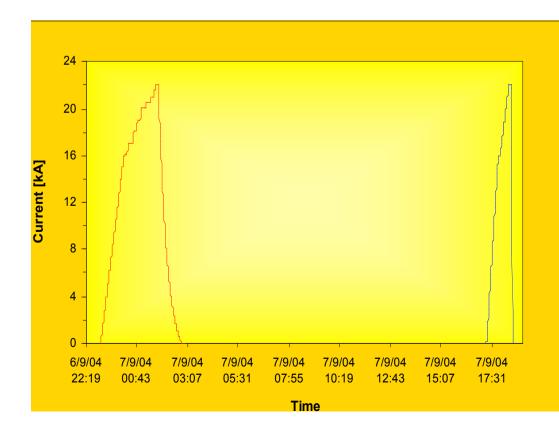
- ✓ large integration effort at CERN from 2003 to 2005
- ✓ several components manufacturing showed manufacturing problems or delays (9 months) but all solved !!

- ✓ One by one all coils have been completed, instrumented, cooled to 4.5 K.
- ... and then tested

Coils tests : slow & fast dumps



- On 7 Sep '04 we charged the coil#1 twice up to 22 kA
- Slow dump (1hr normal ramp down without quench)
- Fast dump (2 minutes emergency ramp down with quench)
- Tested up to 22 kA (nominal 20.5 kA)
- Stability test of 8 h, all fine
- All coils have then been tested with the same procedure, all fine !!





Preparing for installation



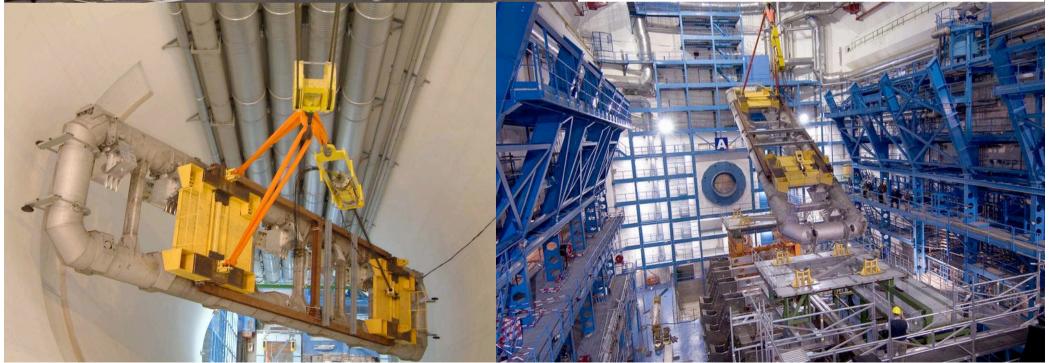


BT Mechanical Assembly (1)





- ✓ Difficult but safe manipulations
- ✓ Lowering using 2 lifting frames
- ✓ Hydraulic winch with load capacity 190T (subcontracted)



BT Mechanical Assembly (2)



- ✓ First the lower 4 coils
- and a lot of temporary support structures





BT integration

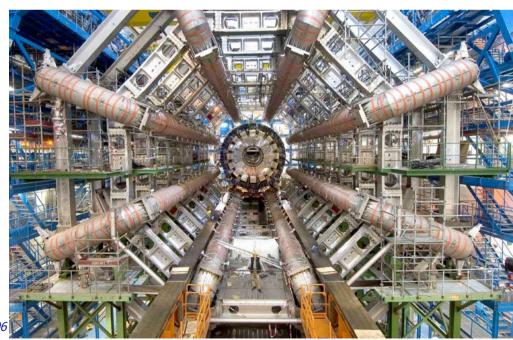


- ✓ Great engineering performance. Project executed with ATLAS technical personnel (~25 FTE, more than 35000 working hours, no accidents)
- ✓ Nearly 3000 bolts pre-loaded and ~ 1600 tons manipulated

Mechanically assembled as an oval, then supports released. Circular shape reached with 20mm envelope over the 25 m

.... almost perfect!

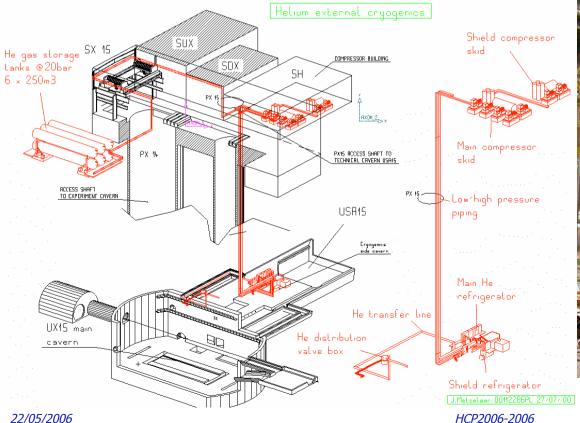
✓ Then services installation (controls, cables, pumps, vacuum pipes, proximity cryogenics, safety systems,...)



Magnets cryogenics plant



- ✓ Installation of He and N2 plants is completed and commissioned
- ✓ Linde refrigerator (20 kW @ 40-80 K; 60kW with pre-cooling) for cooling down and maintaining thermal shield at 50-80K
- ✓ Air Liquide Helium liquefier (6 kW @ 4.5 K) to fill and maintain 11 kL in the storage dewar

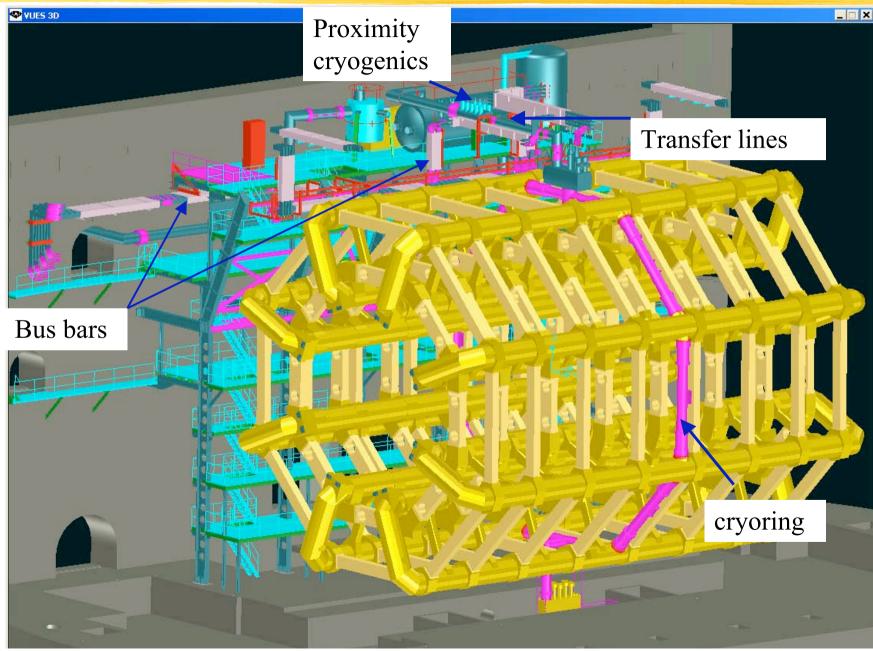


22/05/2006



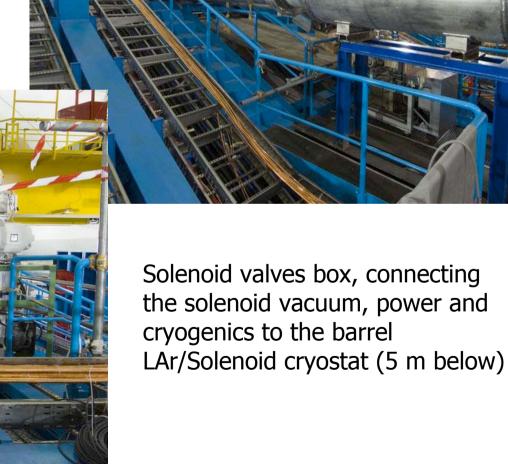
Proximity services





Proximity services

Solenoid and toroid cryogenics transfer lines



BT next steps



Now: Pumping the system to good vacuum ($\sim 500 \text{ m}^3$)

Step 1: Cool down to 4.8K in June-July '06, cleaning of the cavern

from magnetic metallic objects

Step 2: Field tests, few months, mostly overnight

Step 3: Coils warming up and wait for the 2 ECT's and full

magnet test (Spring '07) for the final cool down

Problems:

✓ delivery of last section of busbars late (cable solution for summer tests found)

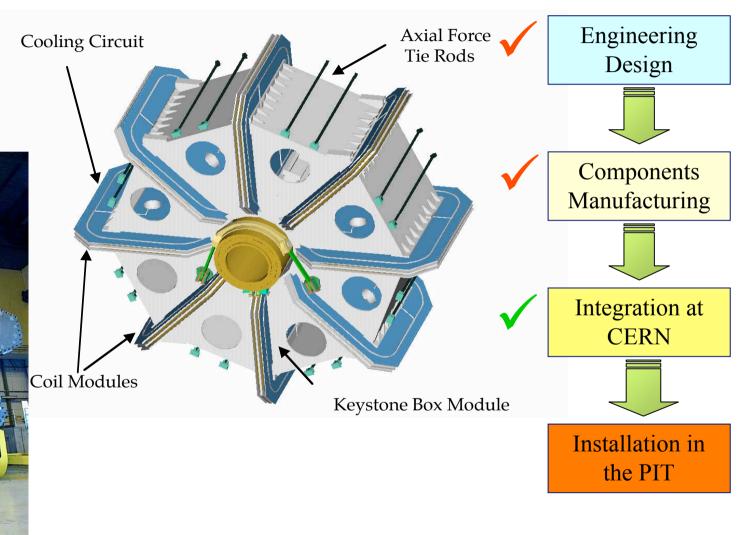
✓ several vacuum problems or false alarms (~4 weeks delays)

✓ a few cryo lines (gas extraction to surface) isolation problematic --> new lines

✓ early tests interfere with other systems installation

The End Cap Toroids





The End Cap Toroids



- ✓ All components manufactured, despite various severe industrial problems
- ✓ Main integration contractor abandoned half way, integration work moved to CERN (Collaboration manpower)
- Cryostats at CERN since long time, all coils prepared and bonded
- ✓ First cold mass now fully integrated and ready for cryostating



ECT integration



Work shows good progress though delayed by a few months due to new technical problems

ECT A:

First Cold Mass A is now being inserted into Vessel A
Thermal shield piping system problems found and solved
It will be moved to the N2 test station end of June '06
80K test on surface (outside bldg. 180)

Then move to cavern by early September '06

for 4 K test and installation (Fall '06)

ECT-C:

Second cold mass pre-assembled Follows ECT A with 3 months delay Ready for installation December '06





Muon Spectrometer Project

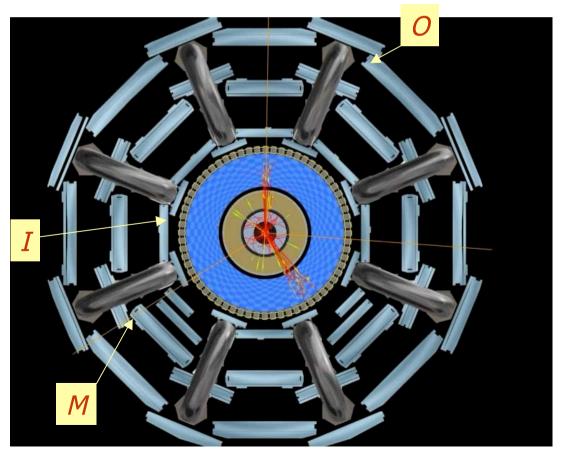
Barrel precision and trigger chambers + small and big wheels in the forward + alignment

Production over 8 years, 1998-2005 Installation over 3 years, 2005-2007

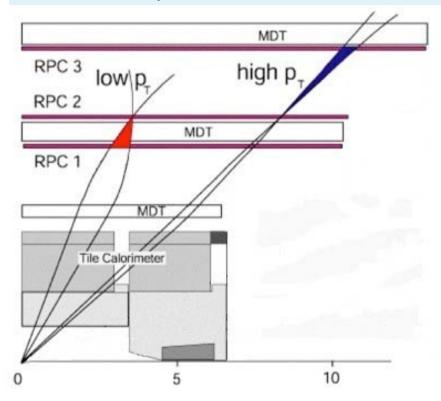
The muon spectrometer (barrel)



Barrel: precision and trigger chambers in 3 layers (588 stations): *I (inner) - M (middle) - O(outer)*



Trigger chambers (RPC) rate capability required ~ 1 kHz/cm²



2 technologies:

MDT - Monitored Drift Tubes (layers: I,O,M)

RPC - Resistive Plate Chambers (trigger) (layers M+M,O)

The muon spectrometer





22/05/2006 HCP2006-2006

MDT

The muon spectrometer (barrel)

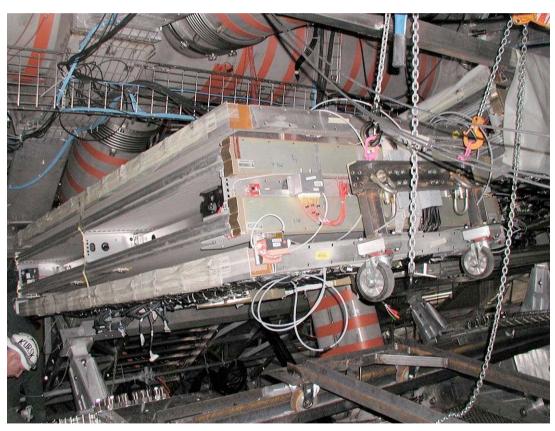


- ✓ All components constructed (MDTs, RPCs, trigger units,...)
- ✓ Stations are assembled at CERN, cabled, activated (gas, LV, HV, alignment, readout,...) and individually tested with cosmics on the surface
- ✓ Transported to Point 1, partially retested just before lowering and then installed in place
- ✓ As far as possible cabling and gas are routed in advance to allow the chambers to be tested just after installation in their final position
- ✓ Installation strategy has been:
 - to install first the chambers in the feet region ->done
 - to install all difficult chambers placed inside the coils volume ->done
 - then to install on rails from both toroid ends the more standard stations, starting from outside to the inside to avoid interference with services routing (pipes and cables) -> ongoing

Barrel muon spectrometer progress



Last five months spent to install first the difficult chambers, the ones sitting inside the coils, the feet structure, --> by now all of these have been installed (\sim 120 units).





Barrel muon spectrometer progress



✓ Since 3 months we are installing the more standard chambers (via support rails) from both toroid end sides (~120 units).

✓ A few difficulties to get started, to tune the process, to learn about the quality control before lowering or just after installation and to get enough chambers prepared and delivered for installation

✓ Today we are installing at a rate of 3.5 units/day on average (37% done), whereas to end in August 2006 we will need to install 4 units/day

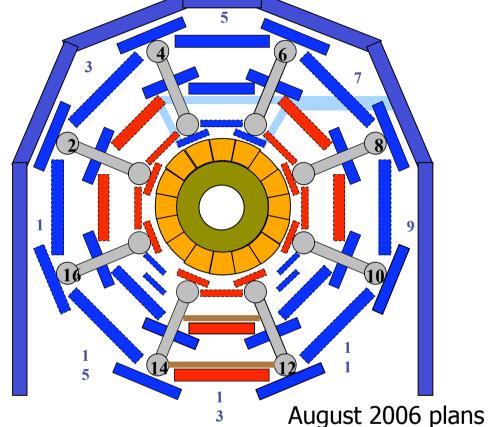
-> from beginning of May we have move to two shifts operation

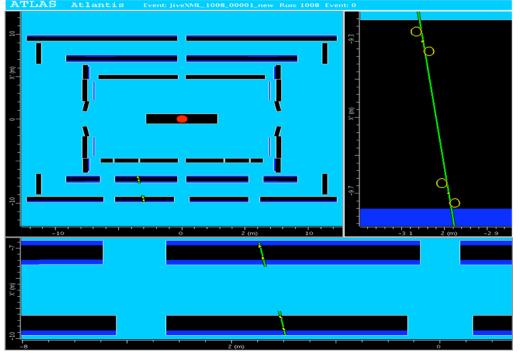
Barrel muon spectrometer



Red: row partly installed

First cosmics tracking in situ

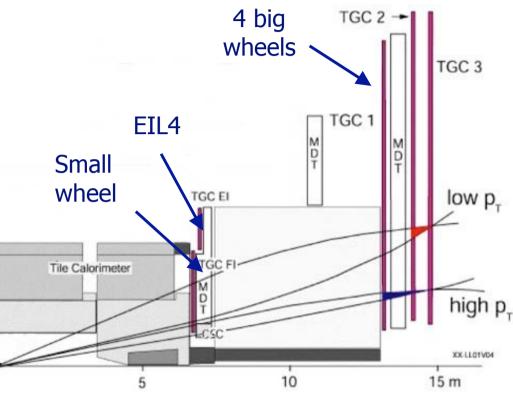




After August 2006 we will have to install ~100 (small chambers) which are today conflicting with the ID cabling work and our need to keep sufficient access to the inside during the next 12 months

The muon spectrometer (forward)



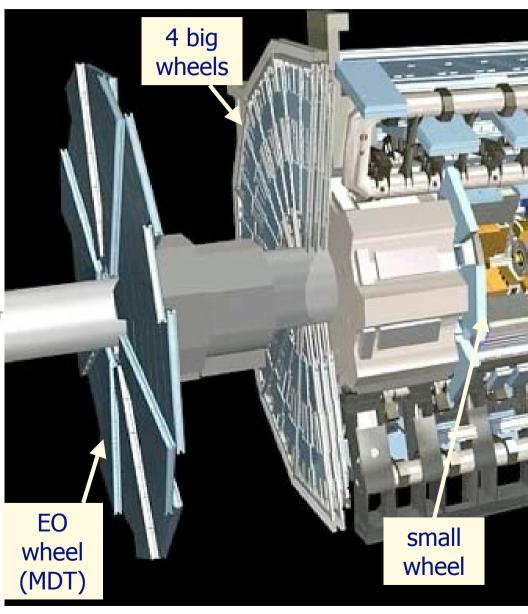


3 technologies:

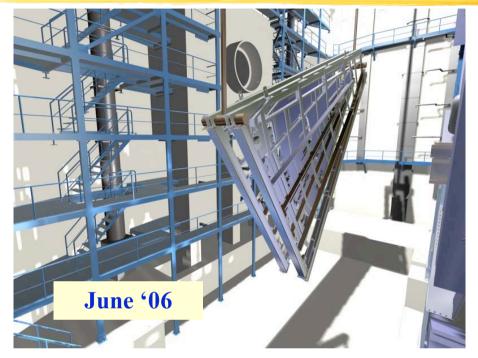
MDT - Monitored Drift Tubes

CSC - Cathod Strip Chambers ($|\eta| > 2$, sm. Wheel)

TGC - Thin Gap Chambers (trigger)



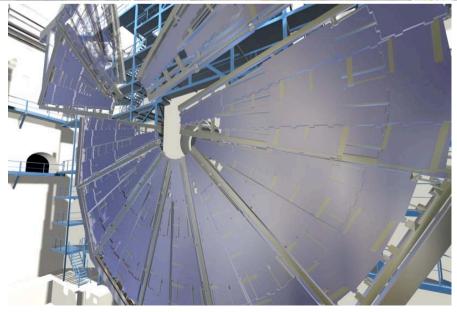
The muon spectrometer (wheels installation)





4 wheels on each side, 24 m diameter

- √ installation in octants (sectors)
- ✓ each octant is instrumented and tested on the surface
- ✓ the production of the sectors is well advance installation in underground is just starting (right now tooling)



The muon wheels sectors assembly





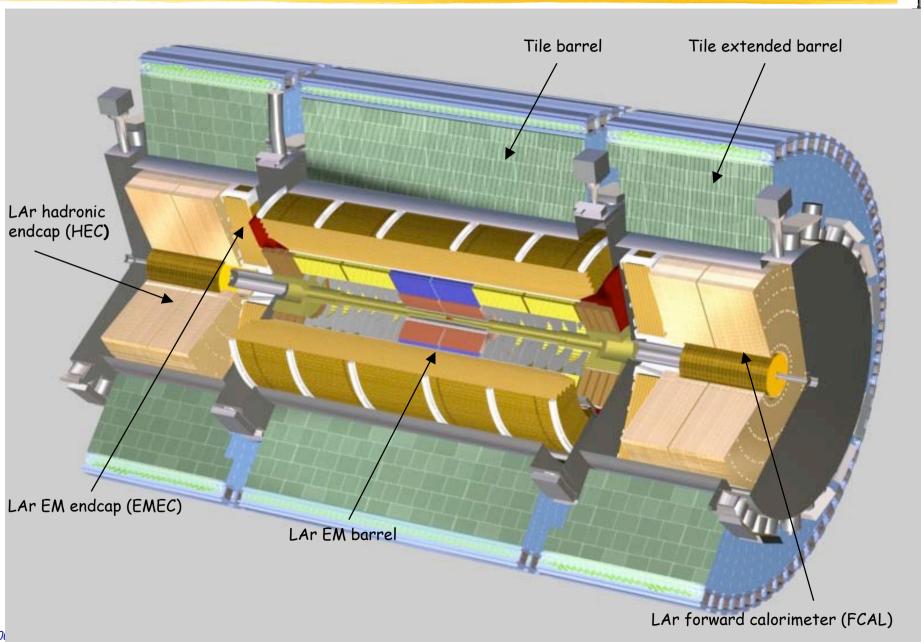
Calorimeters Project

EM LAr + HAD LAr + LAr forward + HAD Tiles + cryogenics + services

Production over 10 years, 1996-2005 Installation over 3 years, 2004-2006

Calorimetry ($|\eta| < 5$)

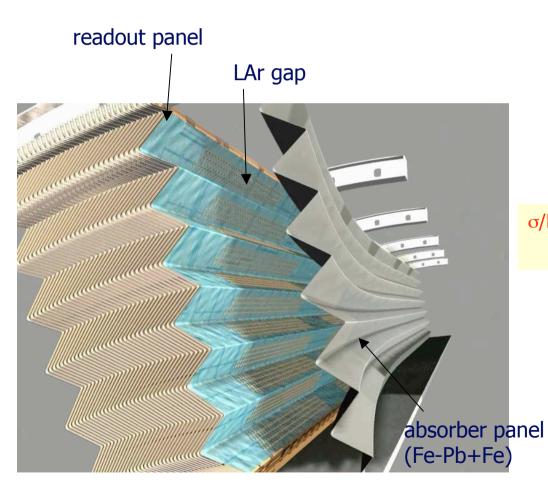


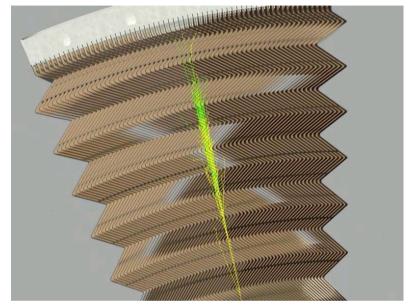


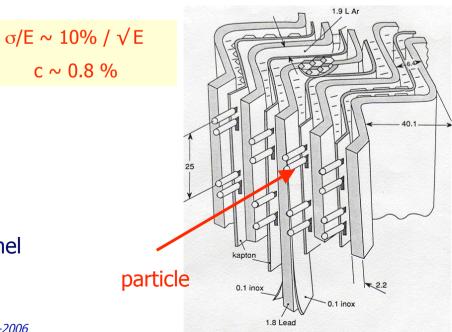
LAr EM Calorimetry



accordion geometry

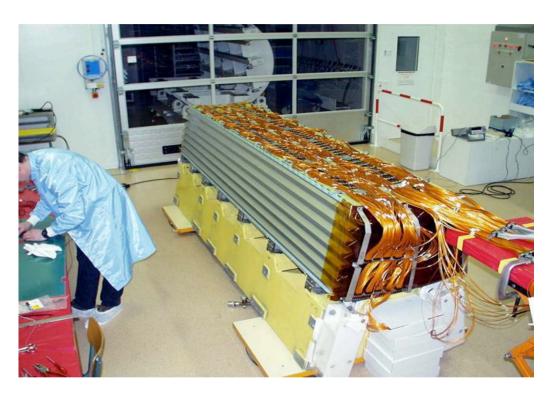






LAr EM Calorimetry







- 1024 accordion absorber plates
- 16 identical modules
- $\eta < 1.7$

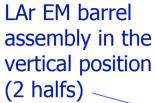
Completely stacked series LAr EM barrel module

- Inner + Outer wheel
- 768 (256) accordion absorbers/wheel
- 8 identical modules/wheel
- $1.375 < \eta < 3.2$

Series LAr EM endcap module during stacking

LAr EM Calorimetry

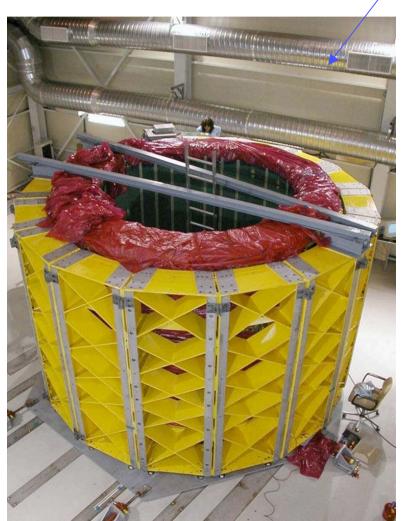






LAr EM endcap wheel during assembly





LAr EM Calorimetry



The barrel FM calorimeter is installed in the cryostat, and after insertion of the solenoid, the cold vessel has been closed and welded

The warm vessel has been closed as well, the detector has been cooled down

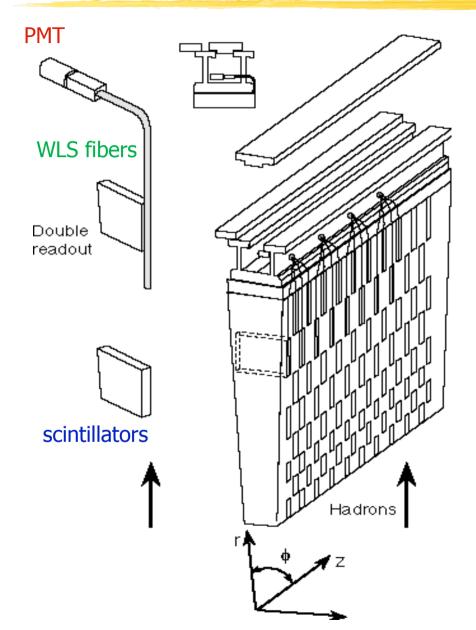
The final cold tests of the barrel FM have been done over summer 2004 with excellent results (<1% d.c.)

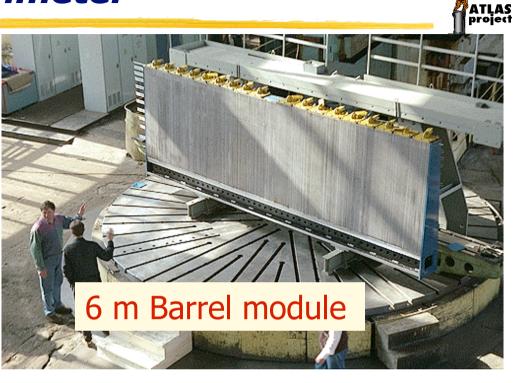


The first of the two LAr endcap EM calorimeter wheels inserted in the cryostat (for side C)

The second wheel has been completed as well and inserted into the side-A cryostat

Tile Calorimeter







Tile Calorimeter





0.25 (0.44+-0.01)/sqrt(E) + (0.024+-0.001) 0.15 0.1 0.05 0.1 0.2 0.3 0.4 1./sqrt(Ebeam) ~ 3000 tons of hadronic calorimeter: iron absorber, active material scintillator (60 tons) read-out by WLS green fibers (1100 Km). Acts also as return yoke for inner solenoid



HCP2006-2006

Barrel Tile Calorimeter lowering





ATLAS project



Barrel LAr Calorimeter lowering



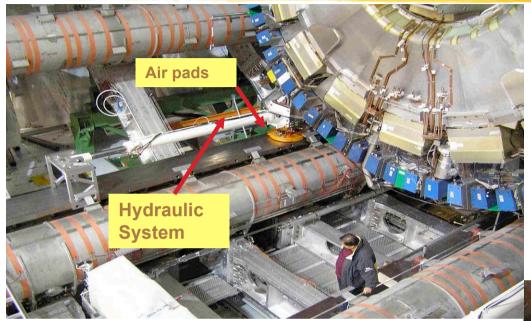






Barrel Calorimeters

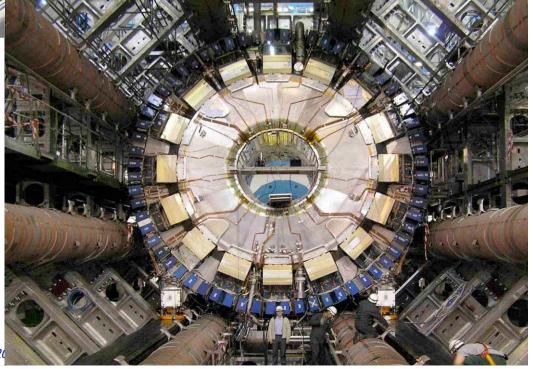




~ 1600 tons barrel calorimeters have been inserted and positioned in their final location around the interaction point (precision < 1mm)

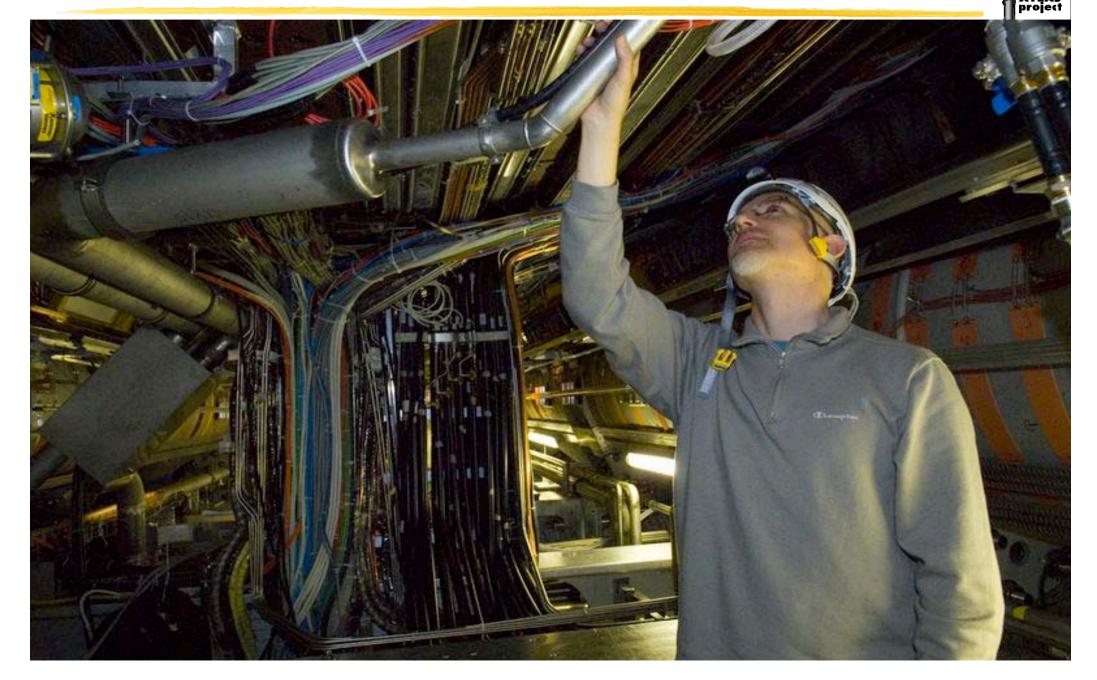
Since then:

- ✓ All LAr cryogenics pipes connected, vacuum done All cryogenics and service lines for the solenoid installed and tested
- ✓ All calorimeters cables (trigger, controls, safety, power, readout) installed up to the USA15 counting room
- ✓ Electronics cooling system installed, commissioned
- ✓ Front end electronics debugging started



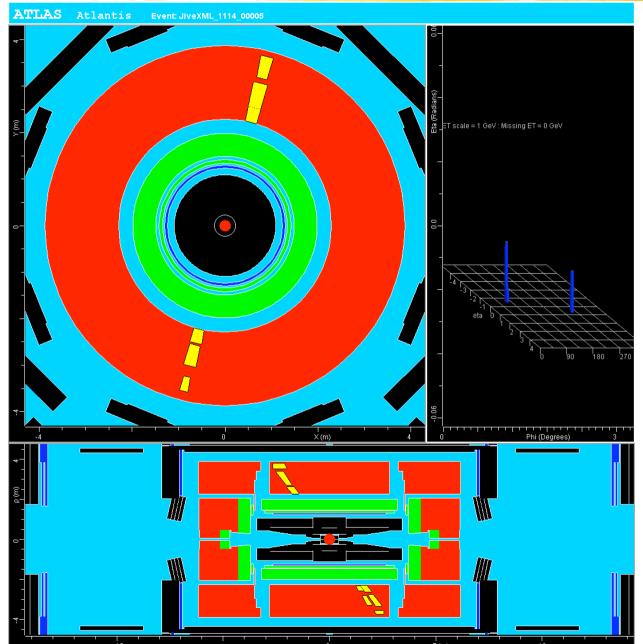
22/05/2006 H

Barrel Calorimeters (1/8 of all services)



Calorimeters cosmics tests



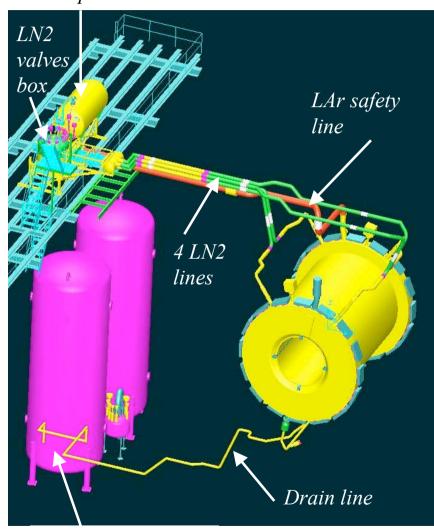


First cosmic muon events registered in ATLAS using the Tile Hadron Calorimeter

Barrel Calorimeters



LAr expansion vessel

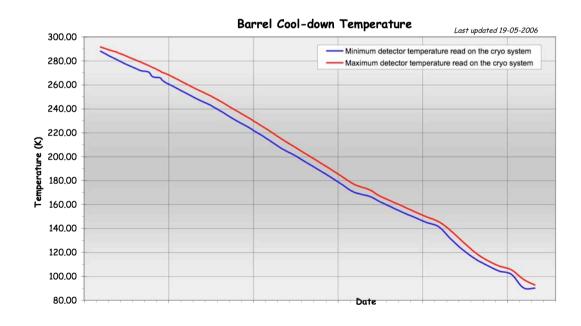


LAr tank (50m3)

Since 30 days we are cooling down, first with gas! (~ 4-5 deg/day), final temp reached!

~ 95 tons of LAr are already in the cavern dewars ready for the cryostat filling

Last week the final cooling down of the central solenoid has started too, targeting end of May for readiness



Central Solenoid integration and test





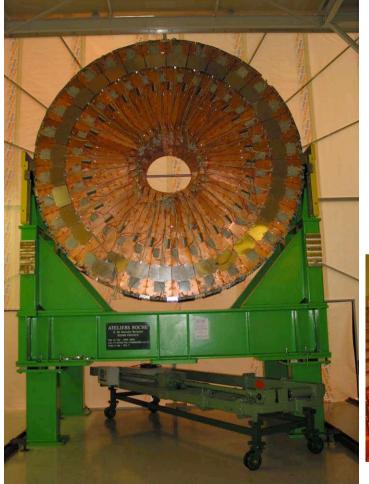
During on-surface test at CERN in Jul 04 it achieved, after 2 training quenches at 7950 and 8110 A (both beyond the nominal current 7600 A), the test maximum of 8130 A (6% safety margin)

- Cooled down in May '04
- Surface test in June '04
- Test completed in July '04
- Installed into the cavern Oct '04
- Cooled down in May '06
- Final field map scheduled in July '06

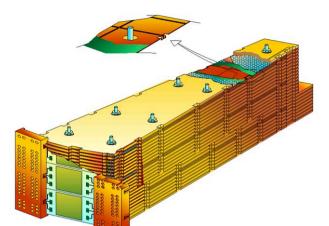


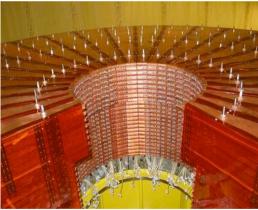
Coil is healthy and accepted for installation

LAr Hadronic



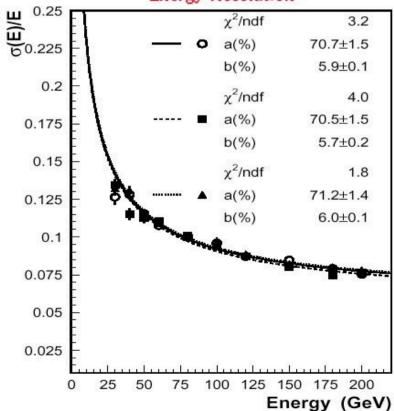






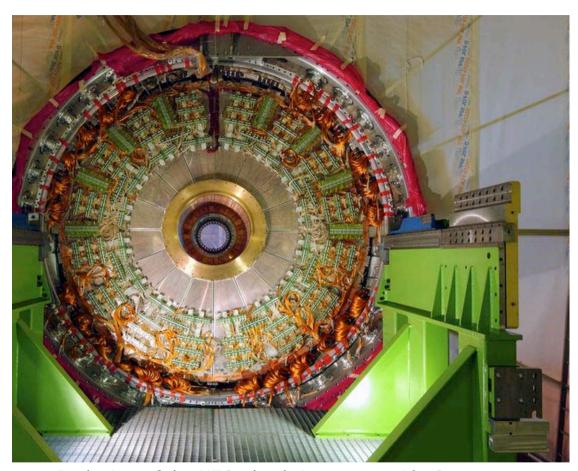
ATLAS project

Testbeam Results: Pions Energy Resolution



LAr Hadronic & Forward Calorimetry





Back view of the HEC wheels in cryostat side-C

The LAr hadronic endcap (HEC) wheels are all assembled, and were inserted in the cryostat (side A & C) and tested with very good results

The LAr forward calorimeters (FCAL) are integrated and cold-tested as well.

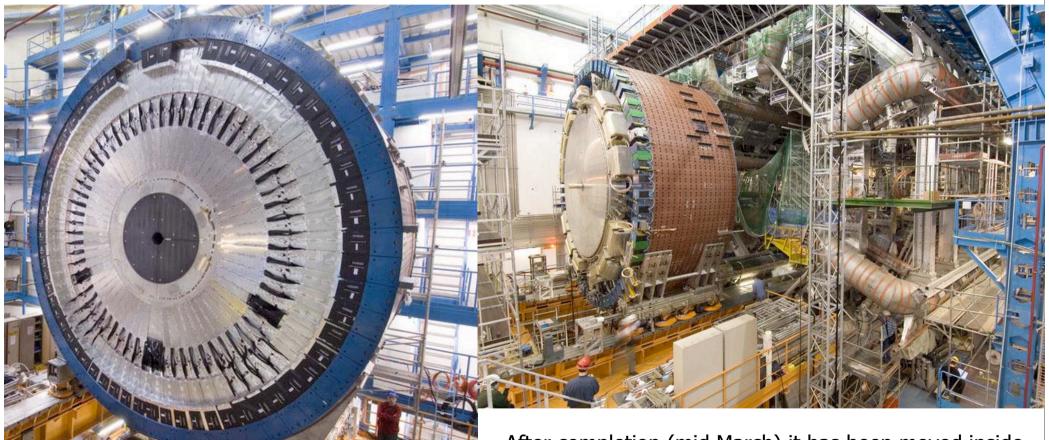


Integrated FCAL ready for insertion

Calorimeters endcap C



Immediately after the move of the barrel calorimeter in its final position (mid Nov), the mechanical assembly of the endcap C has started.



After completion (mid March) it has been moved inside the toroid, in parking position, and services connection has started (cryogenics, flexible chains,...)

Calorimeters endcap A



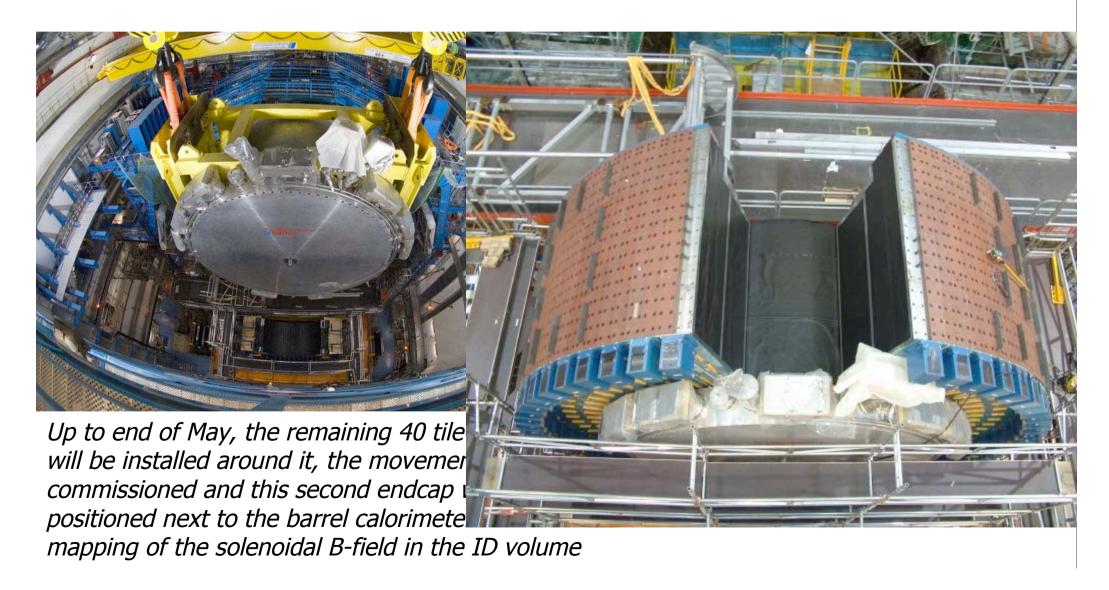
Since March we have started the mechanical assembly of the last endcap A. The LAr vessel was just lowered and positioned on the Tile Calorimeter (1/3 already assembled) end of April.



Calorimeters endcap A



Since March we have started the mechanical assembly of the last endcap A. The LAr vessel was just lowered and positioned on the Tile Calorimeter (1/3 already assembled) end of April.

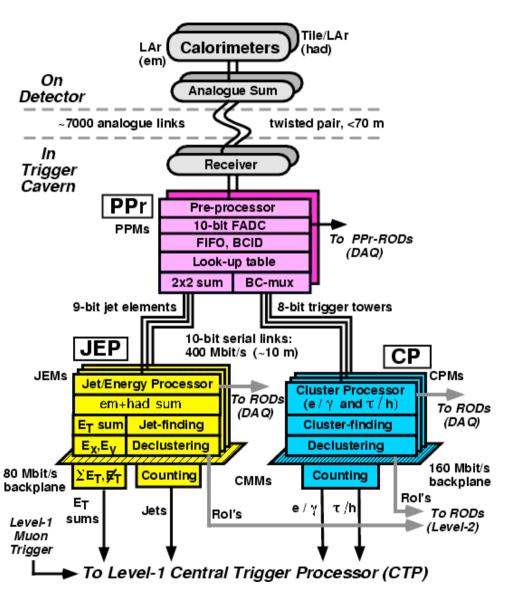


LVL1 calorimeter trigger



- Analogue electronics on detector sums signals to form trigger towers
- ✓ Signals received and digitised

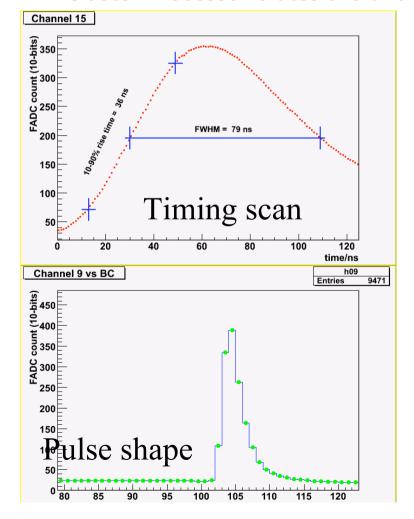
 Digital data processed to measure
 E_T per tower for each BC
 -> E_T matrix for ECAL and HCAL
- ✓ Tower data transmitted to Cluster Processor (only 4 crates in total)
 ~5000 links @ 400 Mbps



LVL1 calorimeter trigger



- Electronics installation full in swing underground, including all cabling
- ✓ Barrel Tiles and LAr are now being connected and debugged
- Cluster Processor crates are under final test



Tiles barrel commissioning

- ✓ Timing calibration
 - Scan in 1ns steps
 - Determine optimum sampling phase (40 MHz FADC)
- ✓ Energy calibration
 - Scan over energy range
 - Check response to saturated signals
- ✓ Connectivity testing
 - Confirm that signals appear where they are expected







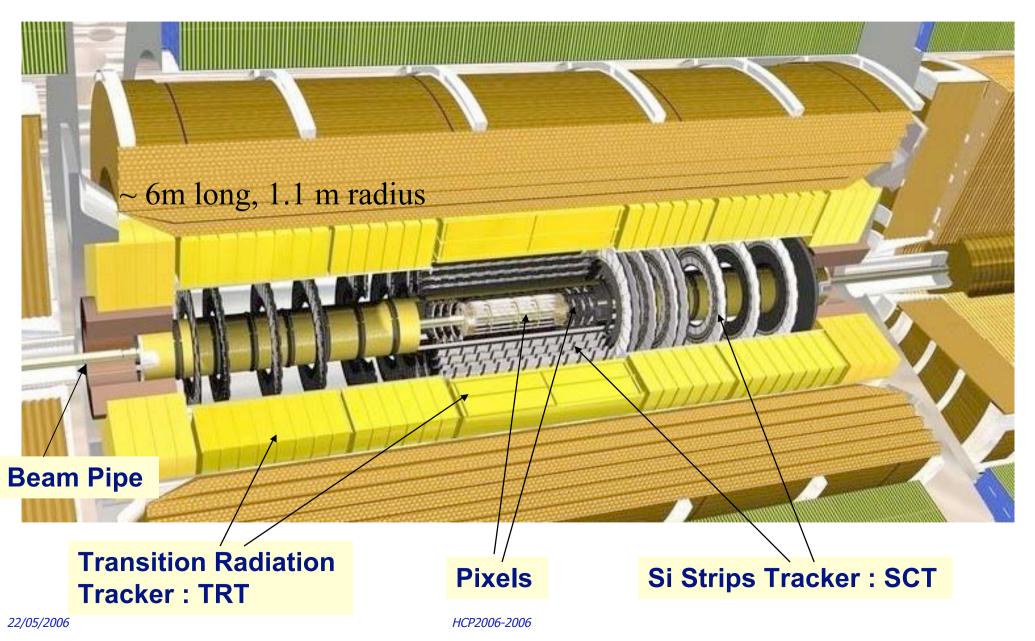
Tracking Project

Pixels + SCT + TRT + services

Production over 8 years, 1999-2006 Installation over 1 years, 2006-2007

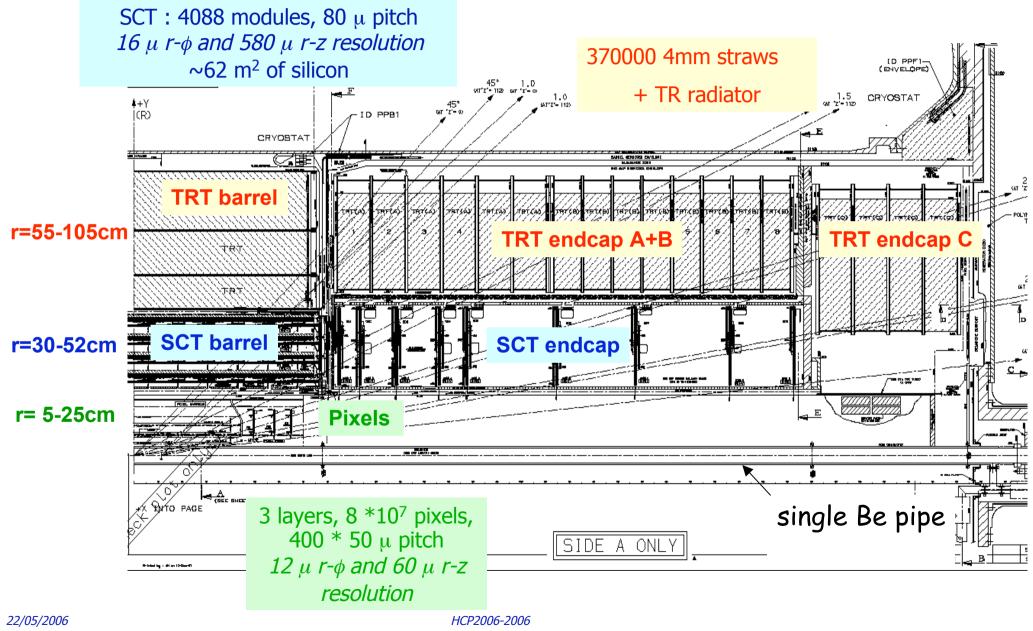
The Tracking Detectors





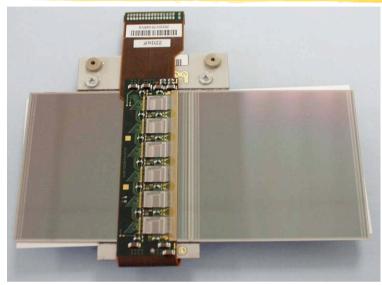
Tracking detectors



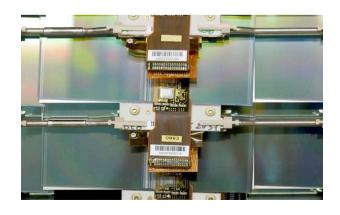


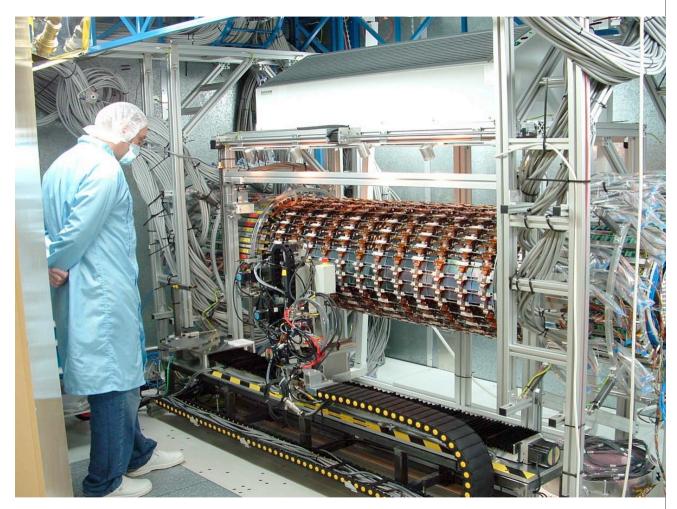
SCT barrels





All sensors procured, all modules have been produced (final yield > 90%). Sensor alignment and position tolerance typically \pm 0.



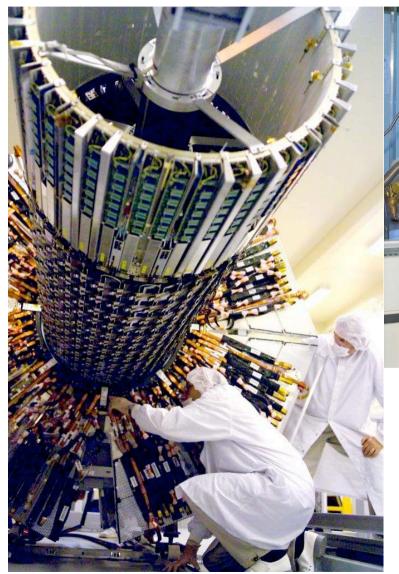


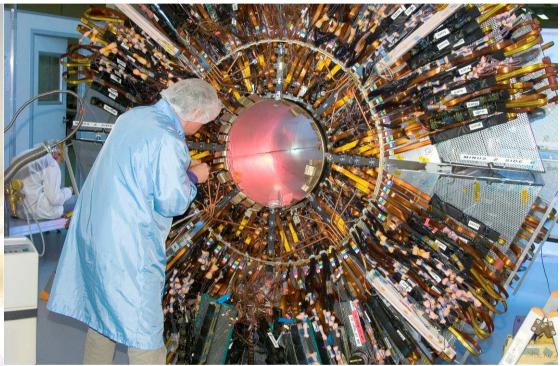
Macro-assembly of the modules on the support cylinder using a dedicated robot. All 4 barrels assembled and now at CERN

SCT barrels



All four barrel cylinders are complete and at CERN



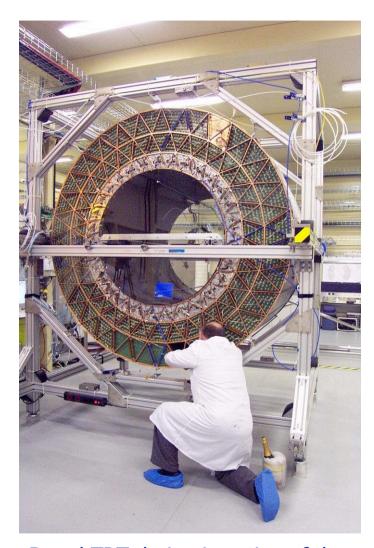


The pictures show different stages of the integration of the four barrel SCT cylinders

The cylinders have been tested: 99.7% of all channels fully functional

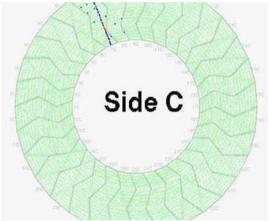
TRT barrel

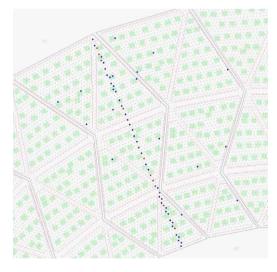




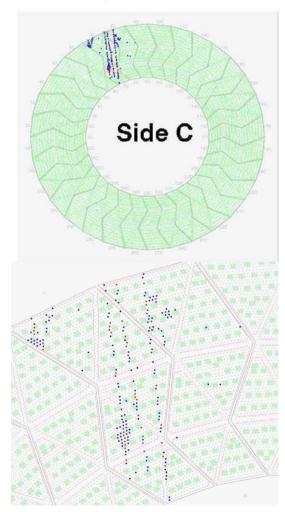
Barrel TRT during insertion of the last modules (February 2005)

Example 1





Example 2



SCT and TRT barrel integration





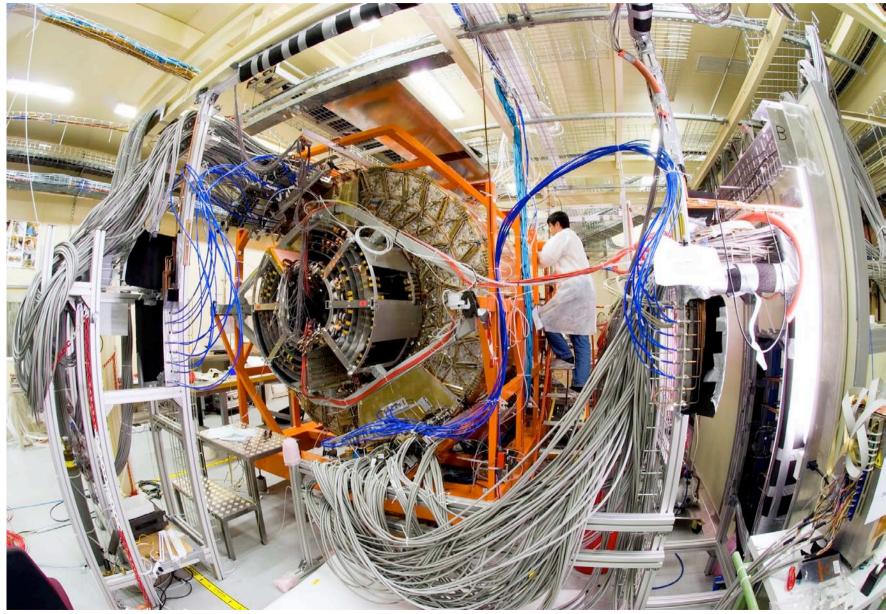
Barrel SCTs (4 cylinders) being inserted inside the TRT barrel

The barrel ID assembly integrated and now ready for installation in ATLAS after going through a final qualification process (up to July '06)



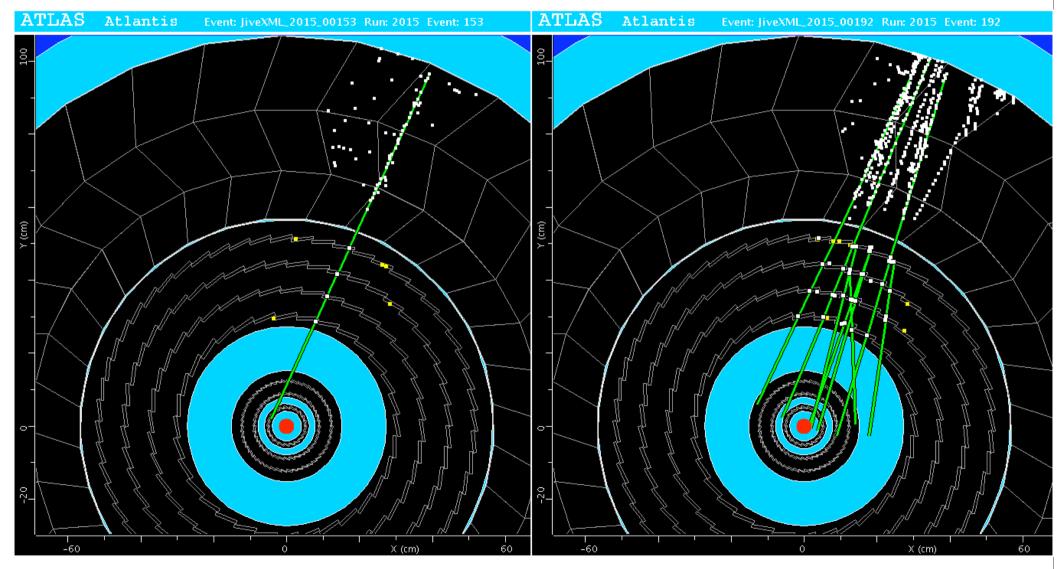
SCT and TRT barrel test





First cosmics events though the barrel ID

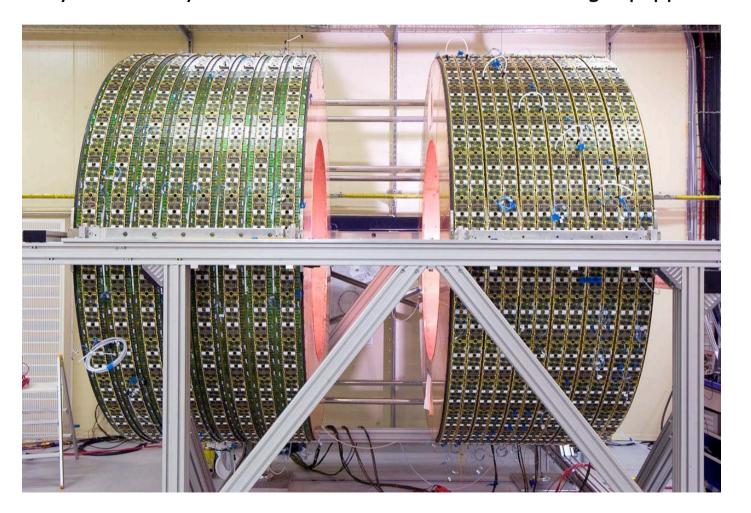




TRT endcaps



The first endcap side (A and B wheels) has been stacked, the second side will be ready end of May 2006 These wheels are now being equipped with services



The first of the two endcap TRTs (A and B type wheels) fully assembled

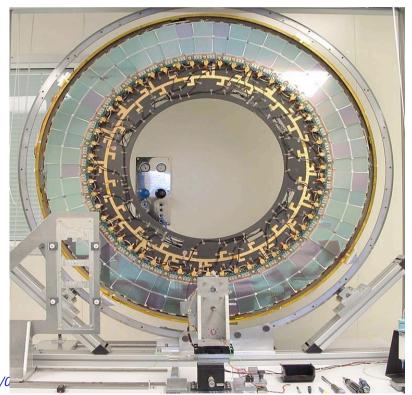
SCT endcaps



All sensors modules produced



All SCT disks assembled and tested



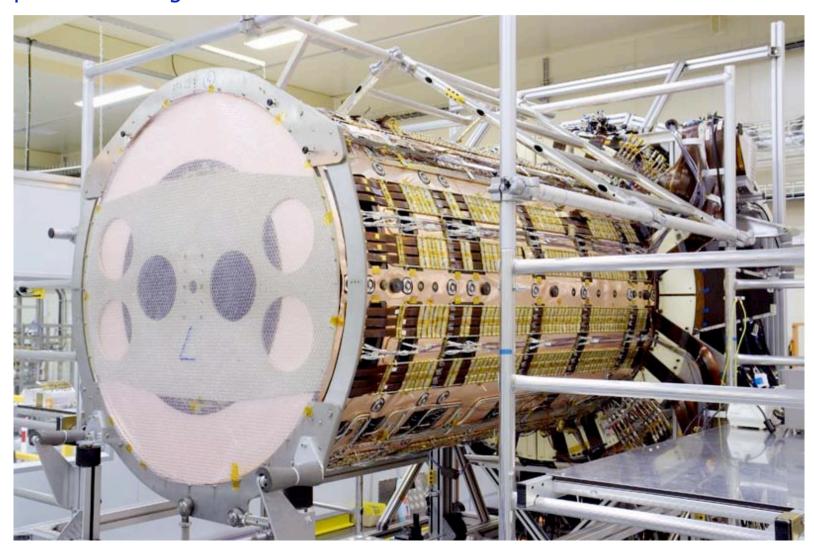
All SCT disks have been integrated in their support structure, all services installed and all components retested



SCT endcaps

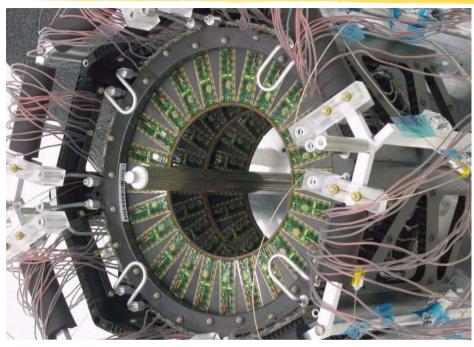


Recently both endcaps cylinders have been moved to CERN (SR1 clean room) and are being fully instrumented and qualified, waiting for final integration with the TRT endcap wheels during the next few months



Pixels detector





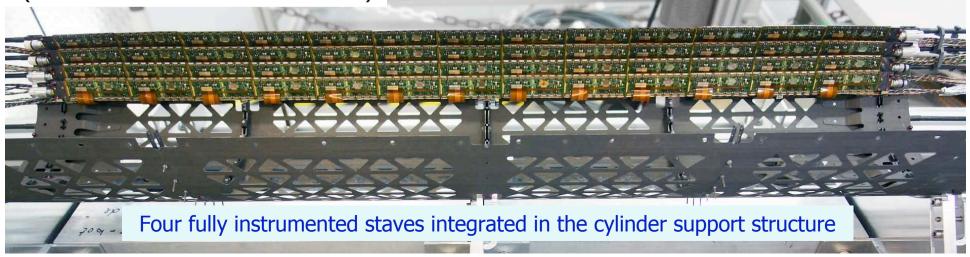
First 3 disks being integrated in their support structure (>0.07% dead channels out of 6.6M)

the Pixel project was affected in 2005 by a technical problem that required highest priority recovery action:

--> Corrosion leaks in the barrel cooling tubes

A repair and replacement strategy was developed, which includes production of new staves for the B-layer, repair of bare staves with new cooling lines, and insertion of new cooling tubes in staves already equipped with glued modules

These actions progress encouragingly well along a tight schedule for installation readiness for Mars 2007



Inner detector services installation



Inner detector services installation





- √ ~ 6'000 bundles of cables, ~2000 gas and cooling pipes to be installed between the inside and electronics racks in the main and service caverns (3/8 cables, all pipes)
- √ ~ 9'000 bundles between racks inside the UX15 cavern and the service caverns USA15 and US15 (80% done)
- ✓ Today the critical path is the installation of the services to the inside, which must be done before the barrel ID is installed (today scheduled for mid August 2006)
- Problems are of different nature (cables availability, genuine technical issues, interference with other systems installation, manpower and organization)
- We are just now increasing the manpower resources adding people and extra shifts

Underground counting rooms activities

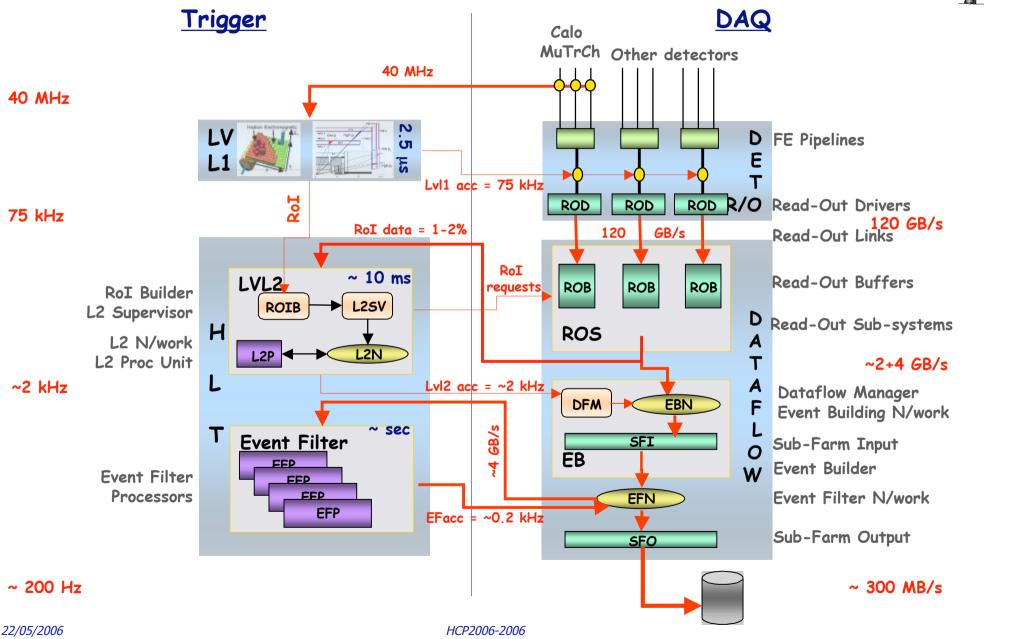


- ✓ Collaboration work in the 5 counting rooms (~600 racks) in full swing, many actors ... many activities of different nature.
- ✓ All necessary infrastructure mostly in place (including safety systems). DAQ and DCS infrastructure and support to users operational.
- ✓ We have established an effective day by day management structure (CRM) to help and support all activities. Typically 30-50 people at any moment working on the electronics. Backbone of a future operation structure.
- Next step is the opening of the main control room and various systems control rooms. Pilot project already operational.



TDAQ architecture





TDAQ progress



A pre-series of the final system (10% of final dataflow) is now in operation at Point-1

Almost 1/3 of the final Read Out System (ROS) has been installed and commissioned in the underground counting room USA15

The infrastructure at Point-1 is now fully operational (including central file servers and a number of local service machines with standard DAQ software, system administration, and networking)

Online software is fully organized. HLT development done in line with the offline code, with a common approach for LVL2 and EF

Components of the DCS are in fabrication or already finished (ELMB), and are already widely used, and the s/w components are available

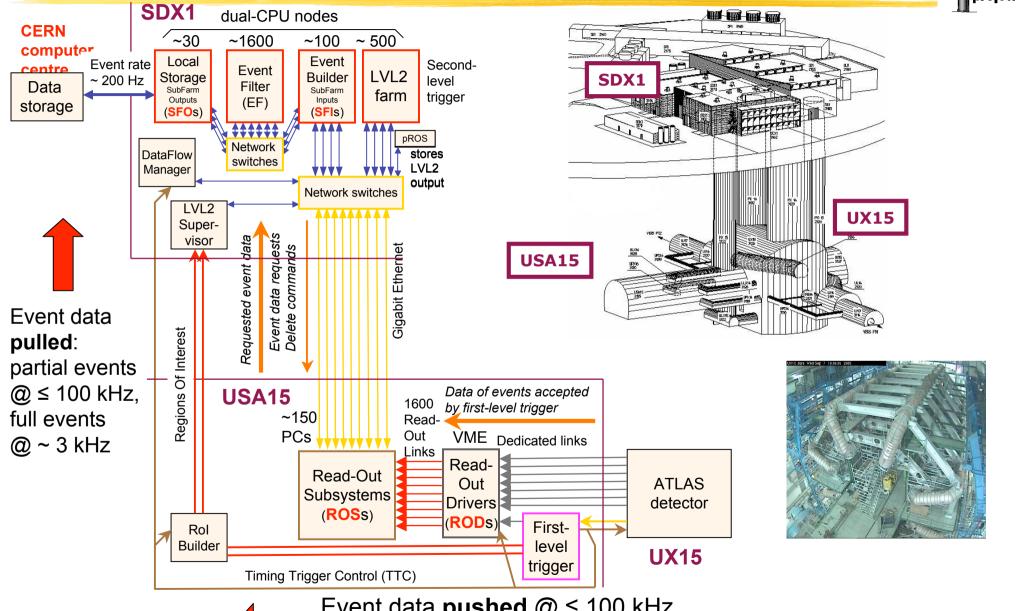
The DCS is one of the first systems already operational at Point 1



ROS racks for the LAr

TDAQ data flow preseries





Event data **pushed** @ ≤ 100 kHz, 1600 fragments of ~ 1 kByte each

Computing project



The computing and software suite has progressed on a very broad front, with a particular emphasis to make it as accessible as possible to the user community

Examples: GRID production tools

Software infrastructure

Detector Description and graphics Framework and Event Data Model

Simulation

Tracking (ID and Muons) and calorimeters (LAr and Tiles)

Database and data management

Reconstruction and Physics Analysis tools

Distributed analysis

Computing System Commissioning along sub-system tests with well-defined goals, preconditions, clients and quantifiable acceptance tests

Examples: Full Software Chain, from generators to physics analysis

Tier-0 Scaling

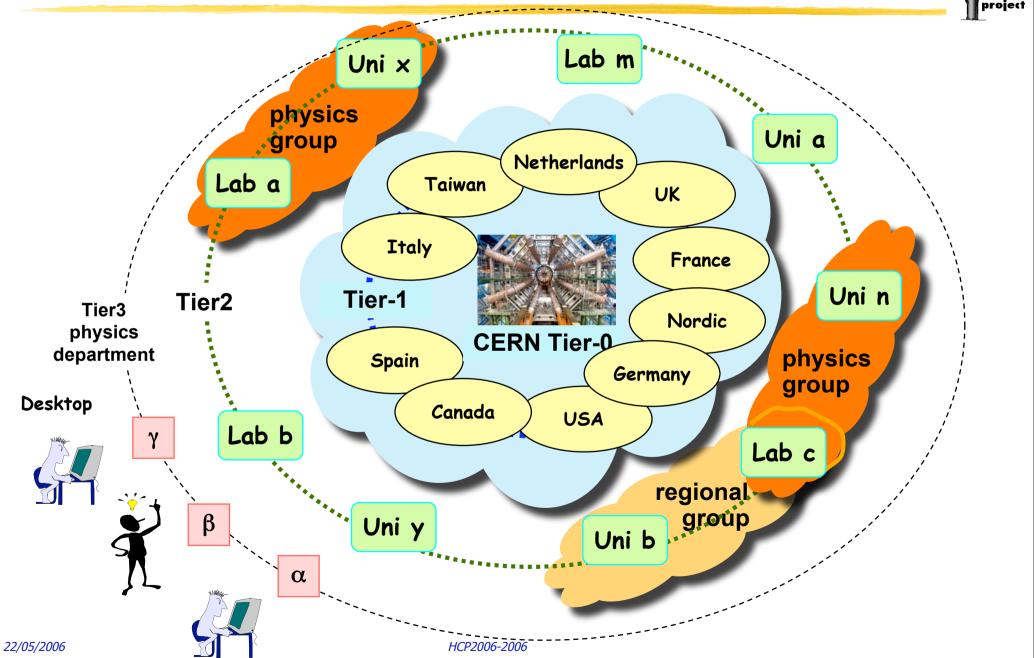
Calibration & Alignment Trigger Chain & Monitoring Distributed Data Management

Distributed Production (Simulation & Re-processing) and Physics Analysis

General 'rehearsal' of TDAQ/Offline data flow and analysis

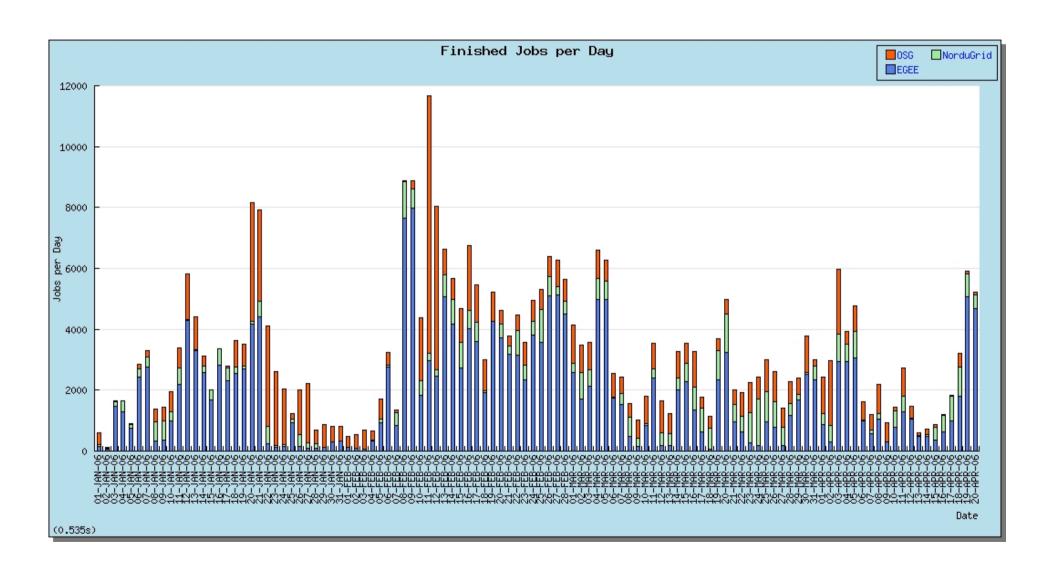
Computing model implementation





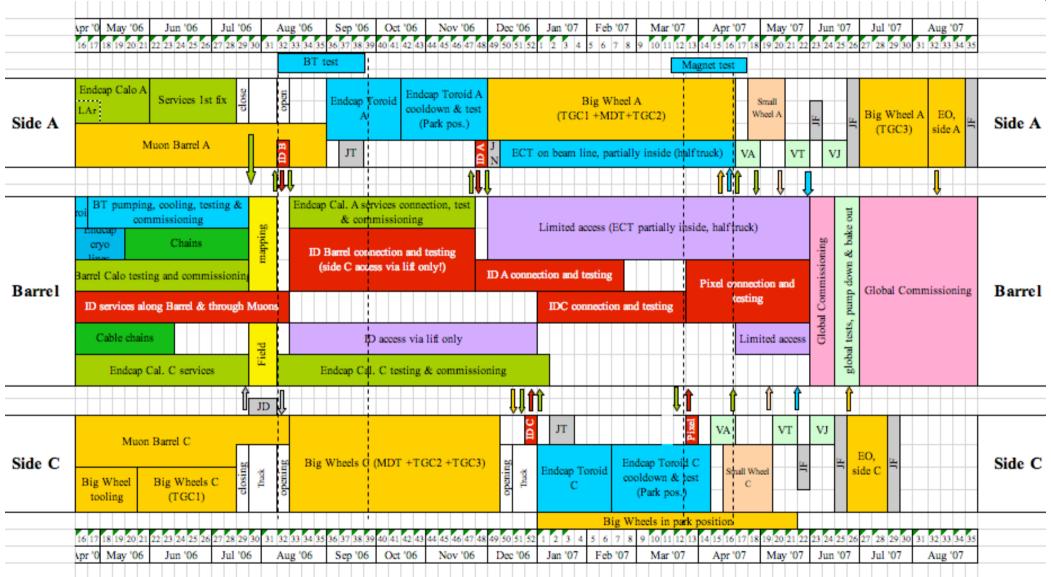
ATLAS job through grid in April 2006





Schedule vers. 7.12





Summary



- ✓ ATLAS installation is proceeding (master schedule 7.12), targeting August 2007 for readiness.
- ✓ Major technical problems of the last 6-8 months solved, we are working now in parallel on many fronts (many more that we expected few years ago !!). Many important milestones have been passed in the construction, pre-assembly, integration and installation of the ATLAS detector components
- ✓ Today's critical path (mostly time) is the installation of all inner detector services and the forward muon big wheels.
- ✓ In the next months we are facing some very critical milestones, like the cooling of the barrel toroid, the finishing of the installation of the services necessary for the installation of the ID, the start of the big wheels installation, the 80K test of the first endcap toroid.
- ✓ Very major software and computing activities are underway as well, using the Worldwide LHC Computing Grid (WLCG) for distributed computing resources
- ✓ In parallel to the installation work of detectors and services, the commissioning of the various components is proceeding well. Cosmics runs are fully part of the process.
- ✓ The next 12 months will be very intense!

